PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61K 9/12, 9/72

A1

(11) International Publication Number: WO 91/14422

(43) International Publication Date: 3 October 1991 (03.10.91)

(21) International Application Number: PCT/US91/02056

(22) International Filing Date: 22 March 1991 (22.03.91)

(30) Priority data:
498,333 23 March 1990 (23.03.90) US

(71) Applicant: MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; 3M Center, Post Office Box 33427 (US).

(72) Inventors: SCHULTZ, Robert, K. ; QUESSY, Stephen, N. ; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(74) Agents: SPRAGUE, Robert, W. et al.; Post Office Box 33427, Saint Paul, MN 55133-3427 (US).

(81) Designated States: AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: THE USE OF SOLUBLE FLUOROSURFACTANTS FOR THE PREPARATION OF METERED-DOSE AEROSOL FORMULATIONS

(57) Abstract

Pharmaceutical suspension aerosol formulations using one or more perfluorinated carboxylic acids or esters thereof as surface-active dispersing agents and 1,1,1,2-tetra-fluoroethane or 1,1,1,2,3,3,3-heptafluoropropane as the propellant are described.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Mali
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland			SN	Senegal
CI	Côte d'Ivoire	KR	Republic of Korea	SU	Soviet Union
CM	Cameroon	LI	Liechtenstein	TD	Chad
CS	Czechoslovakia	LK	Sri Lanka	TG	Togo
DE	Germany	LU	Luxembourg	US	United States of America
DK	Denmark	MC	Monaco		

THE USE OF SOLUBLE FLUOROSURFACTANTS FOR THE PREPARATION OF METERED-DOSE AEROSOL FORMULATIONS

TECHNICAL FIELD OF THE INVENTION

This invention relates to suspension aerosol formulations suitable for the administration of medicaments. More particularly, it relates to pharmaceutical suspension aerosol formulations using 1,1,1,2-tetrafluoroethane or 1,1,1,2,3,3,3-heptafluoropropane as the propellant.

BACKGROUND OF THE INVENTION

Pharmaceutical suspension aerosol formulations currently use a mixture of liquid chlorofluorocarbons as the propellant. Fluorotrichloromethane, dichlorodifluoromethane and dichlorotetrafluoroethane are the most commonly used propellants in aerosol formulations for administration by inhalation.

Chlorofluorocarbons have been implicated in the destruction of the ozone layer and their production is being phased out. Hydrofluorocarbon 134a (HFC-134a, 1,1,1,2-tetrafluoroethane) and hydrofluorocarbon 227 (HFC-227, 1,1,1,2,3,3,3-heptafluoropropane) are viewed as being more ozone friendly than many chlorofluorocarbon propellants; furthermore, they have low toxicity and vapor pressures suitable for use in aerosols.

U.S. Pat. No. 4,352,789 discloses a self-propelling, powder dispensing aerosol composition comprising between about 0.001 and 20 percent by weight of a finely-divided solid material coated with a dry coating of a perfluorinated surface-active dispersing agent of a particular type which constitutes between about 0.1 to 20 percent by weight of the coated solid and a halogenated propellant. The solid material can be a medicament. The

use of 1,1,1,2-tetrafluoroethane or 1,1,1,2,3,3,3-heptafluoropropane as a propellant is not specifically disclosed. Perfluorinated carboxylic acid surfactants are not disclosed.

SUMMARY OF THE INVENTION

This invention provides suspension aerosol formulations comprising an effective amount of a powdered medicament, between about 0.001 and 0.6 percent by weight of a perfluorinated surface-active dispersing agent and a propellant comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,2-tetrafluoroethane and 1,1,1,2,3,3,3-heptafluoropropane, and a mixture thereof.

The perfluorinated surface-active dispersing agent is a perfluorinated carboxylic acid or ester having the general formula

$$R_f - \left[O-\underset{\underset{X}{|}}{CF}-CF_2\right]_n - \left[O-\underset{\underset{X}{|}}{CF}-\right]_m - COOZ$$

wherein R_f is selected from the group consisting of perfluorinated straight chain, branched chain, or cyclic alkyl or combinations thereof containing three to about ten carbon atoms, wherein cyclic alkyl optionally contains one or more catenary oxygen or nitrogen atoms;

each X is independently selected from the group consisting of fluoro and straight chain or branched chain perfluoroalkyl of one to about four carbon atoms;

n and m are independently integers from zero to three with the proviso that the sum of n and m is less than or equal to four; and

Z is selected from the group consisting of hydrogen and straight or branched chain alkyl containing one to about four carbon atoms,

the formulation exhibiting substantially no crystallization of said medicament over a prolonged period,

being substantially readily redispersible, and upon redispersion not flocculating so quickly as to prevent reproducible dosing of the medicament.

The pharmaceutical suspension aerosol formulations of the invention are suitable, for example, for dermal, pulmonary, or mucosal (e.g., buccal or nasal) administration.

DETAILED DESCRIPTION OF THE INVENTION

The term "suspension aerosol" means that the medicament is in powder form and is substantially insoluble in the propellant.

By "prolonged period" as used herein in the context of crystallization is meant at least about four (4) months.

The medicament is micronized, that is, over 90 percent of the particles have a diameter of less than about 10 microns.

The medicament is generally present in an amount effective to bring about the intended therapeutic effect of the medicament. The amount of medicament, however, depends on the potency of the particular medicament being formulated. Generally, the medicament constitutes from about 0.01 to 5 percent by weight of the total weight of the formulation, preferably about 0.01 to about 2 percent by weight of the total weight of the formulation.

Medicaments for delivery by inhalation include, for example, antiallergics, analgesics, bronchodilators, antihistamines, antitussives, anginal preparations, antibiotics, antiinflammatories, hormones, peptides, steroids, enzymes, sulfonamides, or a combination of these.

Examples of medicaments falling within the above therapeutic classes are: isoproterenol hydrochloride or sulfate, phenylephrine bitartrate or hydrochloride, pirbuterol acetate or hydrochloride, disodium cromoglycate, phenylpropanolamine, glucagon, adrenochrome, trypsin, epinephrine bitartrate, ephedrine, narcosine, codeine,

atropine, heparin, morphine, albuterol, albuterol sulfate, triamcinolone acetonide, beclomethasone dipropionate, flunisolide, formoterol, salmeterol, colchicine, neomycin, streptomycin, penicillin, tetracycline, chlorotetracycline, hydroxytetracycline, cortisone, hydrocortisone, prednisolone, and insulin.

Preferred medicaments in the practice of this invention include pirbuterol acetate, pirbuterol hydrochloride, disodium cromoglycate, albuterol sulfate, beclomethasone dipropionate, and triamcinolone acetonide.

Perfluorinated surface-active dispersing agents useful in the invention are perfluorinated carboxylic acids or mixture of such acids that are soluble in 1,1,1,2-tetrafluoroethane, 1,1,1,2,3,3,3-heptafluoro-propane, or a mixture thereof.

Suitable perfluorinated carboxylic acids are those having the general formula:

$$R_f - \left[O-CF-CF_2\right]_n - \left[O-CF-\right]_m - COOZ$$
$$\qquad\quad X \qquad\qquad X$$

wherein R_f is selected from the group consisting of perfluorinated straight chain, branched chain, or cyclic alkyl or combinations thereof containing three to about ten carbon atoms, wherein cyclic alkyl optionally contains one or more catenary oxygen or nitrogen atoms;

each X is independently selected from the group consisting of fluoro and straight chain or branched chain perfluoroalkyl of one to about four carbon atoms;

n and m are independently integers from zero to three with the proviso that the sum of n and m is less than or equal to four; and

Z is selected from the group consisting of hydrogen and straight or branched chain alkyl containing one to about four carbon atoms.

When m and n are zero, the dispersing agent is

perfluoro straight chain, branched chain, cyclic, or a combination thereof, alkanoic acid or ester. Perfluoroalkanoic acids are known and disclosed, e.g., in "Aliphatic Fluorine Compounds", American Chemical Society Monograph Series, Reinhold Publishing Corporation (1958), Chapter VII. Perfluoroalkanoic acid esters are known and disclosed, e.g., in Chapter IX of the same publication.

When either or both of m and n are non-zero, the dispersing agent is an acid- or ester-functional perfluoro mono-, di-, or polyether. Such perfluoroethers are known and disclosed, e.g., in U.S. Pat. Nos. 3,250,808 (Moore et al.) and 4,898,656 (Flynn et al.).

Particularly preferred perfluorinated carboxylic acids include perfluorobutanoic acid, perfluorooctanoic acid, and perfluorocyclohexylacetic acid.

The perfluorinated surface-active dispersing agent preferably has a solubility of at least 0.1 percent by weight, more preferably at least 0.3 percent by weight and most preferably at least 0.8 percent by weight in the propellant.

The perfluorinated surface-active dispersing agent constitutes from about 0.001 to about 0.6 percent by weight, preferably about 0.005 to about 0.5 percent by weight, of the aerosol formulation. The particular preferred amount depends on the particular medicament being formulated and on the particular surface-active dispersing agent being used. It is preferred that the amount of agent used be approximately the minimum needed to provide a suitable suspension.

The hydrofluorocarbon or mixture thereof is preferably the only propellant present in the formulations of the invention. However, one or more other propellants

such as propellant 142b (1-chloro-1,1-difluoroethane) can also be present.

The suspension aerosol formulations of the invention can be prepared by first preparing a solution of the perfluorinated surface-active dispersing agent in the propellant and then suspending the medicament in the solution. In order to prepare a formulation, the perfluorinated surface-active dispersing agent is placed in an aerosol vial, a continuous valve is crimped onto the vial and the vial is pressure filled with the propellant. The vial is shaken on an automatic shaker until all of the dispersing agent is in solution. The micronized medicament is then placed in a separate aerosol vial, a continuous valve is crimped onto the vial and the vial is pressure filled with the previously prepared solution. The medicament is then dispersed in the solution by mixing or homogenizing. If the medicament being formulated is moisture sensitive, these steps should be performed in a dehumidified atmosphere using only dry materials and equipment.

The following examples are provided to illustrate the invention but should not be construed as limiting the invention.

In the following examples the quality of the aerosol suspension is rated on a scale of 1 to 5 with 1 indicating a "poor" suspension and 5 indicating an "excellent" suspension. A poor suspension is characterized by one or more of the following: it has a rapid rate of settling or separation, it is difficult to redisperse after settling or separation, it forms large flocs quickly, and it exhibits crystal formation. In contrast, an excellent suspension is slow to settle or separate, is easily redispersed, has minimal flocculation, and exhibits no crystallization. Substantially no crystal formation, relative ease of redispersion, and absence of rapid flocculation after redispersion are important properties in order to provide reproducible dosing of the medicament.

Absence of substantial crystal formation provides for maximization of the fraction of the dose deliverable to the target area of the lung. Ease of redispersion permits dosing of a uniform suspension. Finally, rapid flocculation results in a large variation in the dose delivered from the aerosol canister. Suspensions exhibiting a rating of 1 or 2 are not considered desirable in terms of an overall balance of properties of degree of crystallization, ease of redispersibility, and nature of any flocculation, whereas ones exhibiting a rating of 3, 4 or 5 are considered desirable and fall within the scope of this invention.

Except as otherwise indicated the propellant in the Examples below is 1,1,1,2-tetrafluoroethane (HFC-134a).

Example 1

A 78.7 mg portion of perfluorooctanoic acid ("FC-26" from 3M) was placed in a 4 ounce vial, the vial was sealed with a continuous valve then pressure filled with 149.5 g of 1,1,1,2-tetrafluoroethane. The vial was then shaken on an automatic shaker for 15 minutes. The resulting stock solution contained 0.05% by weight of perfluorooctanoic acid. A 100 mg portion of micronized pirbuterol hydrochloride was placed in a 15 cc vial along with 5 ml of glass beads, the vial was sealed with a continuous valve then pressure filled with 20 g of the previously prepared stock solution. The vial was shaken on an automatic shaker for 10 minutes then placed on a WIG-L-BUG™ grinder/mixer for 30 seconds. The resulting suspension contained 0.5% by weight of pirbuterol hydrochloride and had a quality rating of 5 (excellent).

Examples 2-10

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized pirbuterol hydrochloride was prepared. Table 1

shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 1

Example	Surface-Active Dispersing Agent		Rating
2	0.002%	perfluorooctanoic acid	1
3	0.006%	perfluorooctanoic acid	4
4	0.01%	perfluorooctanoic acid	4
5	0.3%	perfluorooctanoic acid	5
6	0.006%	perfluorobutanoic acid	5
7	0.012%	perfluorobutanoic acid	5
8	0.059%	perfluorobutanoic acid	5
9	0.310%	perfluorobutanoic acid	5
10	0.507%	perfluorobutanoic acid	5

Examples 11-20

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized pirbuterol acetate was prepared. Table 2 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 2

Example	Surface-Active Dispersing Agent		Rating
11	0.002%	perfluorooctanoic acid	1
12	0.006%	perfluorooctanoic acid	2
13	0.01%	perfluorooctanoic acid	2
14	0.05%	perfluorooctanoic acid	3
15	0.3%	perfluorooctanoic acid	3
16	0.006%	perfluorobutanoic acid	2
17	0.012%	perfluorobutanoic acid	2
18	0.059%	perfluorobutanoic acid	2
19	0.310%	perfluorobutanoic acid	2
20	0.507%	perfluorobutanoic acid	2

Examples 21-29

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized albuterol sulfate was prepared. Table 3 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 3

Example	Surface-Active Dispersing Agent		Rating
21	0.002%	perfluorooctanoic acid	1
22	0.006%	perfluorooctanoic acid	1
23	0.01%	perfluorooctanoic acid	1
24	0.05%	perfluorooctanoic acid	1
25	0.3%	perfluorooctanoic acid	1
26	0.006%	perfluorobutanoic acid	1
27	0.012%	perfluorobutanoic acid	1
28	0.310%	perfluorobutanoic acid	1
29	0.507%	perfluorobutanoic acid	1

Examples 30-39

Using the general method of Example 1, a series of suspension aerosol formulations containing 1.5 percent by weight based on the total weight of the formulation of micronized disodium cromoglycate was prepared. Table 4 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 4

Example	Surface-Active Dispersing Agent		Rating
30	0.002%	perfluorooctanoic acid	3
31	0.006%	perfluorooctanoic acid	4
32	0.01%	perfluorooctanoic acid	3
33	0.05%	perfluorooctanoic acid	3
34	0.3%	perfluorooctanoic acid	3
35	0.006%	perfluorobutanoic acid	3
36	0.012%	perfluorobutanoic acid	3
37	0.059%	perfluorobutanoic acid	4
38	0.310%	perfluorobutanoic acid	2
39	0.507%	perfluorobutanoic acid	2

A preferred disodium cromoglycate formulation is the same as Example 31 above except the drug concentration is 0.5 percent by weight drug. This formulation had a suspension quality rating of 5.

Examples 40-49

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized epinephrine bitartrate was prepared. Table 5 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-

active dispersing agent used and the suspension quality rating.

Table 5

Example	Surface-Active Dispersing Agent		Rating
40	0.002%	perfluorooctanoic acid	2
41	0.006%	perfluorooctanoic acid	2
42	0.01%	perfluorooctanoic acid	2
43	0.05%	perfluorooctanoic acid	2
44	0.3%	perfluorooctanoic acid	2
45	0.006%	perfluorobutanoic acid	2
46	0.012%	perfluorobutanoic acid	2
47	0.059%	perfluorobutanoic acid	2
48	0.310%	perfluorobutanoic acid	2
49	0.507%	perfluorobutanoic acid	2

Examples 50-62

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.3 percent by weight based on the total weight of the formulation of micronized triamcinolone acetonide was prepared. Table 6 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 6

Example	Surface-Active Dispersing Agent		Rating
50	0.05%	perfluorooctanoic acid	4
51	0.05%	isopropyl perfluoro-cyclohexanecarboxylate	2
52	0.05%	perfluoro-2-ethoxy-ethoxyacetic acid	3
53	0.05%	methyl perfluoro-2-ethoxyethoxyacetate	3
54	0.05%	perfluoro-2-butoxy-propionic acid	2
55	0.005%	perfluoro-2-butoxy-propionic acid	2
56	0.05%	perfluoro-3-butoxy-propionic acid	3
57	0.05%	methyl perfluoro-3-butoxypropionate	3
58	0.05%	isopropyl perfluoro-2-butoxyethoxy acetate	3
59	0.05%	perfluoro-2-hexyloxy-ethoxyacetic acid	3
60	0.005%	perfluoro-2-hexyl-oxyethoxyacetic acid	4
61	0.05%	perfluoro-3-octyloxy-propionic acid	3
62	0.005%	perfluoro-3-octyloxy-propionic acid	3

Examples 63-72

Using the general method of Example 1, a series of suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized pirbuterol acetate was prepared. Table 7 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 7

Example	Surface-Active Dispersing Agent		Rating
63	0.05%	isopropyl perfluoro-cyclohexanecarboxylate	2
64	0.05%	perfluorocyclo-hexylacetic acid	4
65	0.05%	perfluoro-2-ethoxyethoxy-acetic acid	5
66	0.05%	methyl perfluoro-2-ethoxyethoxyacetate	5
67	0.05%	perfluoro-2-butoxypropionic acid	5
68	0.05%	perfluoro-3-butoxy-propionic acid	5
69	0.05%	methyl perfluoro-3-butoxypropionate	4
70	0.05%	isopropyl perfluoro-2-butoxyethoxyacetate	5
71	0.05%	perfluoro-2-hexyloxy-ethoxyacetic acid	5
72	0.05%	perfluoro-3-octyloxy-propionic acid	5

Examples 73-76

Using the general method of Example 1, a series of suspension aerosol formulations containing 1.5 percent by weight based on the total weight of the formulation of micronized disodium cromoglycate was prepared. Table 8 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 8

Example	Surface-Active Dispersing Agent		Rating
73	0.05%	isopropyl perfluoro-cyclohexanecarboxylate	2
74	0.05%	perfluoro-2-butoxypropionic acid	5
75	0.005%	perfluoro-2-butoxypropionic acid	4
76	0.05%	isopropyl perfluoro-2-butoxyethoxy acetate	5

Examples 77-78

Using the general method of Example 1, two suspension aerosol formulations containing 0.5 percent by weight based on the total weight of the formulation of micronized albuterol sulfate were prepared. Table 9 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 9

Example	Surface-Active Dispersing Agent		Rating
77	0.05%	perfluoro-2-butoxy-propionic acid	4
78	0.005%	perfluoro-2-butoxy-propionic acid	3

Examples 79-83

Using the general method of Example 1, a series of suspension aerosol formulations containing micronized beclomethasone dipropionate was prepared. Table 10 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating. In the suspensions of Examples 79-81 the medicament was present in an amount by weight of 0.1% and in those of

Examples 82 and 83 it was present in an amount by weight of 0.3%.

Table 10

Example	Surface-Active Dispersing Agent		Rating
79	0.05%	perfluorooctanoic acid	3
80	0.05%	methyl perfluoro-2-ethoxyethoxyacetate	4
81	0.05%	methyl perfluoro-3-butoxypropionate	4
82	0.05%	perfluoro-2-butoxy-propionic acid	2
83	0.005%	perfluoro-2-butoxy-propionic acid	2

Examples 84-87

A 10.99 g portion of beclomethasone dipropionate and about 81.8 g of acetone were placed in a 4 ounce glass vial and warmed on a steam bath until a solution was obtained. The solution was divided evenly among four 4 ounce vials each containing approximately 100 mL of 1,1,1,2-tetrafluoroethane. The vials were placed in a refrigerator overnight. The resulting precipitate was collected by filtration then dried under vacuum to provide beclomethasone dipropionate-1,1,1,2-tetrafluoroethane clathrate. The clathrate was micronized using a fluid energy micronizer. Using the general method of Example 1, a series of suspension aerosol formulations containing 0.1% by weight based on the total weight of the formulation of the micronized clathrate was prepared. Table 11 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating.

Table 11

Example	Surface-Active Dispersing Agent		Rating
84	0.05%	methyl perfluoro-3-butoxypropionate	5
85	0.05%	perfluoro-3-butoxypropionic acid	5
86	0.05%	perfluoro-2-ethoxy-ethoxyacetic acid	4
87	0.05%	methyl perfluoro-2-ethoxyethoxyacetate	5

Examples 88-91

A series of aerosol suspension formulations in which 1,1,1,2,3,3,3-heptafluoropropane (HFC-227) serves as the propellant was prepared using the general method of Example 1. Table 12 shows the amount (percent by weight based on the total weight of the formulation) and identity of the surface-active dispersing agent used and the suspension quality rating. The formulations of Examples 88 and 89 contained 0.5 percent by weight based on the total weight of the formulation of micronized pirbuterol acetate. Those of Examples 90 and 91 contained 0.3 percent by weight of micronized triamcinolone acetonide.

Table 12

Example	Surface-Active Dispersing Agent		Rating
88	0.05%	perfluorooctanoic acid	4
89	0.05%	perfluoro-2-butoxy-propionic acid	4
90	0.05%	perfluorooctanoic acid	3
91	0.05%	perfluoro-2-butoxy-propionic acid	3

WHAT IS CLAIMED IS:

1. A suspension aerosol formulation, comprising: a propellant comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,2-tetrafluoroethane and 1,1,1,2,3,3,3-heptafluoropropane, and a mixture thereof; a therapeutically effective amount a powdered medicament; and between about 0.001 and 0.6 percent by weight based on the total weight of said formulation of a surface-active dispersing agent of the formula

$$R_f - \left[O-CF(X)-CF_2 \right]_n - \left[O-CF(X)- \right]_m - COOZ$$

wherein R_f is selected from the group consisting of perfluorinated straight chain, branched chain, or cyclic alkyl or combinations thereof containing three to about ten carbon atoms, wherein cyclic alkyl optionally contains one or more catenary oxygen or nitrogen atoms;

each X is independently selected from the group consisting of fluoro and straight chain or branched chain perfluoroalkyl of one to about four carbon atoms.

n and m are independently integers from zero to three with the proviso that the sum of n and m is less than or equal to four; and

Z is selected from the group consisting of hydrogen and straight or branched chain alkyl containing one to about four carbon atoms,

the formulation exhibiting substantially no crystallization of said medicament over a prolonged period, being substantially readily redispersible, and upon redispersion not flocculating so quickly as to prevent reproducible dosing of the medicament, said formulation exhibiting substantially no crystallization of said medicament over a prolonged period, being substantially

readily redispersible, and upon redispersion not flocculating so quickly as to prevent reproducible dosing of said medicament.

2. A suspension aerosol formulation according to Claim 1 wherein said agent has a solubility of at least 0.8 percent by weight in the propellant.

3. A suspension aerosol formulation according to Claim 1 wherein m and n are zero.

4. A suspension aerosol formulation according to Claim 3, wherein R_f contains three to about seven carbon atoms.

5. A suspension aerosol formulation according to Claim 1 wherein said surface-active dispersing agent is selected from the group consisting of perfluorobutanoic acid, perfluorooctanoic acid, perfluorocyclohexylacetic, acid, and C_1 through C_4 straight chain or branched chain alkyl esters thereof.

6. A suspension aerosol formulation according to Claim 1 wherein said surface-active dispersing agent is selected from the group consisting of perfluoro-2-ethoxyethoxyacetic acid, perfluoro-2-butoxypropionic acid, perfluoro-3-butoxypropionic acid, perfluoro-2-butoxyethoxy-acetic acid, perfluoro-2-hexyloxyethoxyacetic acid, and perfluoro-3-octyloxypropionic acid, and C_1 through C_4 straight chain or branched chain alkyl esters thereof.

7. A suspension aerosol formulation according to Claim 1 wherein said medicament is selected from the group consisting of pirbuterol acetate, pirbuterol hydrochloride, disodium cromoglycate, albuterol sulfate, beclomethasone dipropionate, and triamcinolone acetonide.

8. A suspension aerosol formulation according to Claim 1 comprising 1,1,1,2-tetrafluoroethane as essentially the only propellant.

9. A suspension aerosol formulation according to Claim 1 comprising 1,1,1,2,3,3,3-heptafluoropropane as essentially the only propellant.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 91/02056

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: A 61 K 9/12, 9/72

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	A 61 K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	US, A, 4352789 (C.G. THIEL) 5 October 1982 see claims 1-7,11-18 cited in the application	1,7-9
A	US, A, 3250808 (E.P. MOORE) 10 May 1966 see claims 1,10,13-16; column 9, lines 57-60 cited in the application	1
A	STN Information Services, Data Base: Chemical Abstracts, Accession No.: 89(14): 117545k, & JP, A, 53031582 (DAIKIN KOGYO CO., LTD) 24 March 1978 see the abstract	1,8,9

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
3rd July 1991	09. 09. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	miss T. MORTENSEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9102056 SA 46393

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 27/08/91
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4352789	05-10-82	None	
US-A- 3250808		None	